The Cary Arboretum

of The New York Botanical Garden

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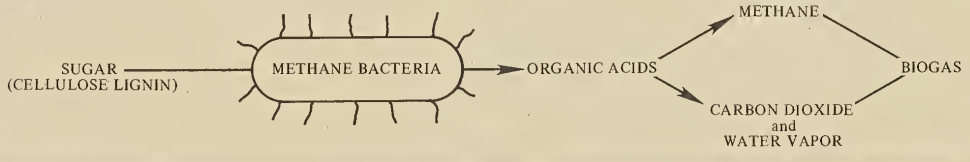
Methane Energy at the Arboretum

by Dr. Willard W. Payne, Director

The Arboretum has recently entered into a joint project with Bionomic Resources Corporation of New York, Fernando Gallo, President, to refine processes of methane production and utilization in temperate regions. The ecological consequences of such energy decentralization technology can be very great, and the project also will have important agricultural potential.

The energy of industry in America today is largely not nuclear and not solar or wind, but photosynthetic energy trapped by green plants from sunlight and stored in their tissues in bygone ages. The original product of photosynthesis by plants is the simple sugar, glucose, $C_6H_{12}O_6$, with six carbon atoms, twelve hydrogen atoms, and six oxygen atoms. Because of this inclusion of carbon, oxygen, and hydrogen, sugar is technically a carbohydrate. Glucose is manufactured within green tissue from atmospheric carbon dioxide (CO_2) and from water (H_2O). The manufacturing or conversion process requires energy that is incorporated into the bonds that hold the sugar atoms into their new configurations. Some of the oxygen of CO_2 and H_2O is given off as a waste product; note that $C_6H_{12}O_6$ is atomically the same as $6CH_2O$, so that the equivalent of the oxygen fraction of the carbon dioxide portion is lost (six oxygen atoms per sugar molecule).

When the plant, or when animals use the carbohydrate for energy, the oxygen is recombined as the sugar is metabolized, and carbon dioxide and water are recovered. The waste product of this chemical reaction is the energy, which can be trapped in other molecules and used to warm our bodies or perform work or push along other chemical reactions so that we can build proteins, for instance.



A great deal of the sugar originally manufactured by plants ends up in the cell walls of leaf or other tissues, and especially of wood. The chief chemical substance of wood and all higher plant cell walls is cellulose, consisting of long strings of glucose molecules linked in a chain (or polymer) like beads on a necklace. In wood, significant amounts of glucose are also transformed into lignin, the strengthening material that makes a thin sheet of oak wood tougher than a lettuce leaf. Lignin is incorporated into later-formed layers of the cell wall.

Most industrial energy comes from derivative products of these carbohydrates after being transmuted by geochemical forces. Coal is a solid that consists of nearly pure carbon.

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More than Herbs

In 1973, when the Arboretum was in its first stages of development, Dr. Thomas Elias initiated a program to collect, identify, and preserve many kinds of dried specimens for study. This collection of museum specimens was the first step in organizing the Arboretum's herbarium.

Today, with the help of several staff members and volunteers, the herbarium contains over ten thousand specimens representing virtually every plant family found in the Mid-Hudson Valley, and many others, as well. A grand opening, slated for May 14, will honor those who have devoted countless hours among stacks of herbarium sheets, glue brushes, and labeling equipment.

Pixie Williams is one of the devoted volunteers who, since September, 1979, has worked over 500 hours in the quiet, windowless herbarium rooms located on the lower level of the Plant Science Building. As a nature lover, and one who is constantly striving to quench a thirst for botanical knowledge, she finds the responsibility for organizing the herbarium a challenging and educational experience. She and other volunteers, including Betty Smith and Marta Greene, have sorted, organized, and filed thousands of specimens collected by many botanists into a useable, comprehensive plant reference file.

Pixie Williams displays a specimen of Pinus pithyusa Stev collected by Dr. Elias in the U.S.S.R. in 1976.

"One particularly challenging project," notes Pixie, "was preparing 22 large cartons of specimens collected in the Pacific Northwest by Soviet Botanists." Since the standard method of collecting plants includes the use of newspaper to press and separate specimens, each one had to be carefully removed from its American newsprint and put into "plain wrappers" before being shipped to the Soviet

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Methane Energy at the Arboretum

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Petroleum is a complex mixture of hydrocarbons, substances made only of hydrogen and carbon from which the oxygen has been lost. These have high combustion energy potential, reflected in their lack of oxygen. When burned or exploded, great heat or pressure are obtained, and this is especially valuable to generate electrical energy, drive automobiles, and perform other tasks that demand huge quantities of energy available more or less continuously.

As we exhaust the world supply of fossil hydrocarbons, as their availability is influenced by complex world politics, and as we view the polluting effects of and the appallingly wasteful shortsightedness of using precious hydrocarbons only for energy, we are impelled to turn again to considering the possibility of using photosynthetic energy from standing forest or agricultural resources in industrially useful ways.

In its simplest form, we use this energy when we build a bonfire and roast dinner, or when we build a wood fire in a stove and heat our home. In the combustion process, carbon dioxide that was absorbed from the air originally is returned to the air in precisely the same amount, and no harmful buildup can occur. Oxygen that was released to the atmosphere to make the carbohydrate is recombined in precisely the same amount, and the original water is released as a vapor by-product.

Wood, however, is an inconvenient fuel. It will not go through gas lines, it is cumbersome and heavy, and it is quickly burned so that enormous amounts of energy must be used to maintain the supply. This acquisition or maintenance energy must be subtracted from the energy obtained through combustion to give the net energy yield. If that energy is muscle power, derived from potatoes, hamburgers, and breakfast cereal, and used to saw and carry the wood directly from woodlot to stove, we extend the natural energy cycling, and it need not be subtracted. If that energy is gasoline for a truck and chain saw, we are exchanging to some degree fossil fuel energy for non-fossil, and the trade-off is often of questionable benefit, and may even be a net loss.

There are other ways, however, in which sugar energy in cellulose or other plant derivative substances can be converted into industrial energy, and one of these that has great potential is biological production of methane and other fuels. Methane is the simplest hydrocarbon, CH_4, consisting of a single carbon atom surrounded by four hydrogen atoms. It is a light, odorless gas that can be burned directly to produce heat and light, can be used to power generators or vehicles, or can be converted to liquid fuels such as wood alcohol, methanol, CH_2OH.

In the experiments to be conducted by the Arboretum and Bionomic Resources Corporation, emphasis will be placed on using voluminous waste products of agricultural processes, and initial work will focus on hardwood sawdust. Dutchess County, New York, is one of the largest areas of hardwood lumber production in the United States. Oak, ash, poplar, and maple, especially, are selectively harvested from our forests, cut into planks, and sold to manufacturers of flooring and furniture. Some of the trimmings have value for paper production, but the sawdust accumulates as an inescapable waste product that presents a significant disposal problem. Because it is available in large quantity, and already piled or binned for disposal, it is an ideal substance for this work.

At the methane facility near the Arboretum, sawdust will be mixed with suitable microorganisms and water to produce a slurry of the approximate consistency of pudding. Six sealed tanks will hold batches of the mix set up in sequence so that at least five are producing at any given time.

Within the tanks, bacteria and yeasts will break down some of the carbohydrate in the wood, particularly of the lignin, to obtain energy for their own growth and reproduction. Because the tanks will be airtight and no atmospheric oxygen can be obtained, these organisms will not be able to convert the carbohydrates totally to their original carbon dioxide and water. Instead, a residue of methane will be produced, and a gas that is a mixture of methane, carbon dioxide, and water vapor will bubble out of the slurry. This gas is called biogas. The biogas, because of its methane content, can be burned to produce heat and steam, or can be used to fuel electrical generators. For this project, some biogas will be used at the site of production to power a generator that will provide electricity for the facility, and some will be piped to the nearby Plant Science Building. There it will power generators which will produce all of the electricity needed for that building, and waste heat from the generators will augment the solar heat used to warm the building. If all goes well, the 33,000-square-foot Plant Science Building, with its library, laboratories, teaching facilities, and administrative offices will be completely freed from need for fossil fuel energy.

The process of fermentation that will be used was developed originally in Guatemala by agronomic engineer Mario D. Penagos. There are now thirteen of these facilities operating in Guatemala, using a variety of agricultural materials, including cottonseed and sugar cane residues. Mr. Penagos will come to Millbrook shortly to supervise construction of the methane production system here.

Experimental work at the Arboretum will involve aspects of converting this high-yielding process from one suitable for tropical regions to one that can be reliably carried out in temperate climates. The fermentation is temperature dependent, and can be harmed by conditions that are either too cold or too warm. We will also participate in developing simple techniques for converting excess methane, available in the summer months, to easily stored alcohol.

Equally important will be work with the fermentation residues. Both the liquid and solid portions are valuable organic fertilizers. For modern agriculture, as much as 25 percent of the total energy required to produce a crop is incorporated into artificially produced fertilizers. This can amount to the equivalent of three to four barrels of crude oil per acre per year for sugar cane, for example.

At the Arboretum, with guidance from Ecologist Dr. Robert E. Tillman and Chemical Ecologist Dr. Clive G. Jones, and with practical experimentation directed by Horticulturist Robert S. Hebb, we shall explore use of these fertilizers and soil conditioners under actual garden, greenhouse, and nursery conditions. At the same time, Bionomic Resources Corporation will explore mechanisms of making them available in acceptable ways to modern farmers and nurserymen. It may be possible that the protein and other foods incorporated into the yeast and bacterial cells will be a valuable food supplement for cattle, hogs, or poultry.

Thus, the new methane project has remarkable potential for The New York Botanical Garden, for energy, ecology, agriculture, and husbandry. It presents an array of technological uses with important social impact, and will provide an educational display of exceptional relevance. It also may enable here one of the first large experimental facilities in the nation to free itself completely from reliance on irreplaceable fossil fuel energy.

People at the Arboretum

Carol Coutant, Confidential Secretary... possibly the best-dressed of all Cary Staff members, Carol is a quiet, personable young woman who enjoys knitting, writing poetry, and ballet.

Originally from Poughkeepsie, Carol graduated from Our Lady of Lourdes High School and the Krissler Business Institute. Her very first interview was at the Arboretum where she was immediately hired to work in the business office, and, after 4½ years, she laughs at how skeptical she was about taking on such a hectic position.

Carol was promoted to Confidential Secretary to the Director in March, 1980 and enjoys her new responsibilities. "Four years ago," she recalls, "the offices were in farm houses on Fowler Road... but working in the Plant Science Building is much more spacious, and the atmosphere is very peaceful."

Carol is especially fond of the city of San Francisco, where she spent a vacation last year. She also enjoys listening to folk music, working with plants, and cooking "for two or more."

Named Sweetheart of the Year by her co-workers in 1978, Carol lives up to that title simply by being the friendly, amiable person she is.

Betsy Calvin Joins Arboretum Staff

Mrs. Betsy Calvin, a graduate of the New York State Universities of Oneonta and Geneseo, has recently been appointed Assistant Librarian for the Arboretum's unique library located in the Plant Science Building.

A resident of Pleasant Valley, Mrs. Calvin enjoys weaving and gardening. Having special experience in computerized bibliographic searching, she has worked as a librarian for Betz Laboratories near Philadelphia, and for the Mobil Corporation in Princeton, New Jersey.

Mrs. Calvin hopes to expand the library's collection which specializes in horticulture, botany, and wildlife biology, to include more comprehensive coverage of alternative energy and energy conservation, which will help service requests from the surrounding community.

She notes that volunteers are vital to library operation, and are always needed to help process books, work with the vertical files, scan newspapers for useful clippings, and serve as "Acting Librarian" when she is at the New York Botanical Garden's Library in the Bronx.

The Arboretum's circulating collection, which was inaugurated in 1978 with a generous donation from a "Friend of the Arboretum", has expanded greatly during the past two years. Donations of books are always appreciated and are acknowledged through this newsletter and on bookplates.

During the month of March, Mrs. Janet Adams donated $100.00 to the circulating collection. Mrs. McAllister Loeb donated *Hortus Floridus*, by Crispin dePass, and Dr. I.O. Baitulin donated *Systems of Plants of Arid Zones of Kazakhstan*, which was published in the U.S.S.R.

New additions to the circulating collection include:

Behler, John L. et al. *The Audubon Society Field Guide to North American Reptiles and Amphibians,* Knopf, 1979

Williams, Kim. *Eating Wild Plants,* Mountain Press, 1977

Harrington, Geri. *The Wood-Burning Stove Book,* Collier, 1977

MacLatchie, Sharon. *Gardening with Kids,* Rodale Press, 1977

Kramer, Jack. *Philodendrons,* Scribner, 1974.

Geffen, Alice M. *A Birdwatcher's Guide to the Eastern United States,* Barron's, 1978.

The library is open to the public Monday through Friday, 9 a.m. to noon, and 1 p.m. to 4 p.m.

Cary Honors One-Thousandth Friend

Sandra and Allen Shapard admire their Cornus Kousa with their daughter, Mary.

Mr. Allen Shapard and his family had no idea that joining "Friends of the Arboretum" would lead to the April morning they were presented with a *Cornus kousa chinensis* (oriental dogwood) and honored as our one-thousandth member.

According to Janice Claiborne, Membership Secretary, "Friends of the Arboretum" was initiated in 1975 and each spring, a membership drive is undertaken to explain the "features of friendship" to potential members. Memberships are numbered consecutively, and Mr. Shapard's number, one-thousand, is an especially significant one.

Mr. Shapard, who is Manager of a computer systems analysis department at IBM, says he has been aware of the Arboretum's programs and activities since its beginning in 1971. "Until now," he says, "I was too busy and couldn't take advantage of all the Arboretum has to offer."

The Shapards moved to Poughkeepsie from Florida in 1974 and have two children, Mary and David, who attend the Poughkeepsie High School.

Mrs. Shapard, who works for the Assembly of the State of New York, appreciates the tranquility found at the Arboretum, and first visited the grounds last August for a walk-and-drive tour with her parents.

Both agree that being Friends of the Arboretum will offer excellent opportunities to study northeastern vegetation. The *Cornus kousa chinensis*, compliments of Arboretum Director, Dr. Willard Payne, will be an attractive addition to the Shapards' already flourishing dogwood collection.

More than Herbs

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Union because of strict regulations which prohibit American news from reaching Soviet countries. "Luckily, the Western Printing Company of Poughkeepsie donated 1,500 pounds of plain paper for the project," Pixie adds. After examining the thousands of specimens collected by the Russians, she noted that the visitors were most interested in the North American varieties of alpine plants and in wild herbaceous flowering plants, plus seaweed and grasses. According to Dr. Elias, who accompanied the Russians on the 1979 collecting expedition, the plants collected in the Northwest are useful in studying the close relationship between Soviet and North American plant life."

The Arboretum's herbarium is a branch of the New York Botanical Garden's world-famous herbarium, which houses over four million specimens from around the world. "This smaller branch was designed as a reference herbarium, not a major repository as the one in the Bronx," says Dr. Elias. "Now that it is fully functional, it can serve as an excellent resource for staff members and students to identify plants.

It also serves to maintain representative horticultural specimens from the Arboretum's living plant collection. These specimens, including, when possible, examples of seedlings and other developmental stages, constitute a permanent reference file that will far outlive the actual living plants, and are much more convenient for reference." The Arboretum's Horticulture Department has added another unique feature to the herbarium by initiating a seed collection which can be used as an additional teaching aid. Seeds included in this collection are varieties made available to the scientific world through the *Index Seminum*, or "list of plants" from around the world.

The herbarium is divided into three sections. One includes approximately 2,500 sheets of plant material collected in the Mid-Hudson Valley beginning in 1973. The bulk of this collection was made by James Stevenson who is currently a New York Botanical Garden horticulture student. The main section is composed of over 10,000 samples of native and cultivated species grown at the Arboretum and throughout the United States, which serves to help identify plant materials brought into living collections on the grounds. A third and smaller section is devoted to research projects maintained by different members of the scientific staff.

Serious students and Friends of the Arboretum are welcome to use the Arboretum's herbarium by appointment. For more information, please call Dr. Elias at 677-5343, ex. 251.

Around the Arboretum

Recreation and Fitness Day, May 31

A 10-kilometer road race, bicycle tours, fitness testing, and an orienteering contest are just some of the events you and your family can participate in at the Arboretum's Recreation and Fitness Day scheduled for May 31.

According to Dr. Peter Dykeman, Education Coordinator, Recreation and Fitness Day, designed as a family program of human energy activities, will include outdoor demonstrations, games and contests for all ages. A 10-kilometer race along the Arboretum's paved internal road system will be conducted by the Mid-Husdon Road Runners. Registration for the race is 9 a.m. The Frisbee Magic Professional Flying Demonstration Team will present a how-to program of Frisbee tricks. Other demonstrations include fly fishing, photography, canoeing, spelunking, horseback riding and rock climbing.

Recreation and Fitness Day will be held at the Gifford House Education and Visitor Center on the Sharon Turnpike from 9 a.m. to 4 p.m. Admission is $2.00 for adults and $1.50 for children. Children under 8 are admitted free.

Come for the entire day – food and beverages will be available. For more information, contact Dr. Dykeman at the Education and Visitor Center, 677-5358.

Antique Fair Set for June 14

Chinese collectibles, antique jewelry, books and furniture are just some of the items to be exhibited for sale at an Antique Fair sponsored by Millbrook's Nine Partners Garden Club.

The Fair, which will be held on the Gifford House lawn, will benefit the Gifford Garden, scheduled for construction in early Summer. The Nine Partners Garden Club, which has provided able volunteers to the Arboretum throughout the past four years, has been instrumental in developing and staffing the Cary Gift Shop located in the Gifford House Education and Visitor Center on the Sharon Turnpike. Proceeds from the Fair will go directly towards the planning and planting of the Gifford Garden, which is expected to be one of the most outstanding perennial gardens in the area. According to Horticulturist Robert Hebb, this show display, featuring low maintenance perennials, will create a garden that will have much color and interest through as many seasons as possible, and will be accessible to all visitors, including the handicapped.

Participants from Dutchess, Ulster, and Columbia Counties, Connecticut and Massachusetts will offer a wide variety of antiques and collectible items at the Fair, which takes place between 10 a.m. and 6 p.m. Refreshments and plenty of parking will be available. Admission is $1.50 for adults, $1.25 with a coupon, and $1.00 for students and senior citizens. For more information call 677-5343.

Music at the Arboretum

A free program presented by the U.S. Military Stage Band will be one of the three outdoor concerts offered this summer in the beautiful music bowl located in a meadow behind the Gifford House.

The free concert, July 6, will feature the U.S. Military Stage Band from West Point. On July 20, the Hudson Valley Dixieland Ensemble will perform, with a raindate set for July 27. On August 3, the Dutchess Community College Jazz Ensemble, rated one of the finest jazz ensembles in the Hudson Valley, will present a program of hits from the Big Band Era made popular by Glenn Miller, Les Brown, Woody Herman, and Count Basie.

All concerts will begin at 4 p.m. in the music bowl. Bring a blanket, a snack, and spend a relaxing afternoon of music and nature.

Folding chairs will also be available close to the stage on a first-come-first-served basis.

Prices for the Dixieland and Jazz programs are: Adults, $5.00; Friends of the Arboretum, $4.00; and children and senior citizens, $2.50. Tickets are available from Jeanette Gorman, 677-5343, or at the Plant and Gift Shop in the Gifford House on the Sharon Turnpike.

"Art Ten" to Exhibit at Cary

Art Ten, a group of dedicated artists who work in a variety of media, will open a two-building exhibit with a 1:30 - 3:30 gallery reception at the Gifford House Sunday, May 18.

The exhibit and sale, which runs through July 27 in both the Gifford House and Plant Science Building, will include paintings in watercolors, oils and acrylics, drawings on scratchboard, pastels, graphics, and sculpture.

Gallery hours are Monday through Friday, 9 a.m. to 4 p.m., and Sundays, 1:30 to 3:30 p.m.

Non-Industrial Union Comes to Arboretum

In February, in a balloting conducted by the National Labor Relations Board, a simple majority of the labor force of the Arboretum voted to accept the American Federation of State, County, and Municipal Employees (AFSCME) as its bargaining agency. The Arboretum and AFSCME are currently arranging negotiation sessions to develop a labor contract. It is the hope of both parties that this contract will be one that promotes the well-being of the institution and its employees.

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of
THE NEW YORK
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